

How Movies Break Physics

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Broken Superheroes (+ Supervillains)

I'm going to ruin the fun, sorry



The Flash

The Flash

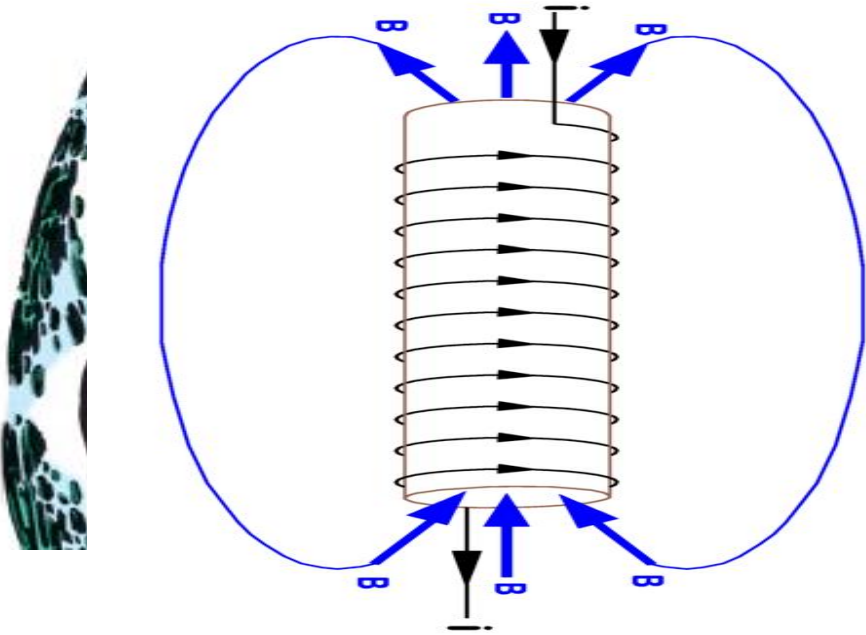
What can he do?

- Move at 'super speed'

But that's OK because 'The Flash likes to stay below mach 10 to avoid environmental damage'

This is known as being 'Hypersonic'

- significant thermal heating
- shockwave damage
- sonic boom



Magneto

Magneto

Pretend Magneto is a solenoid, of 1000 turns, an area of 0.01m^2 and 2m tall.

$$U = \frac{1}{2}(\mu_0 n^2 AL)I^2$$

To lift a 1000kg car 10m off the ground it would take nearly 2900 amps.
Good job he's bold.



Human
Torch

Human Torch

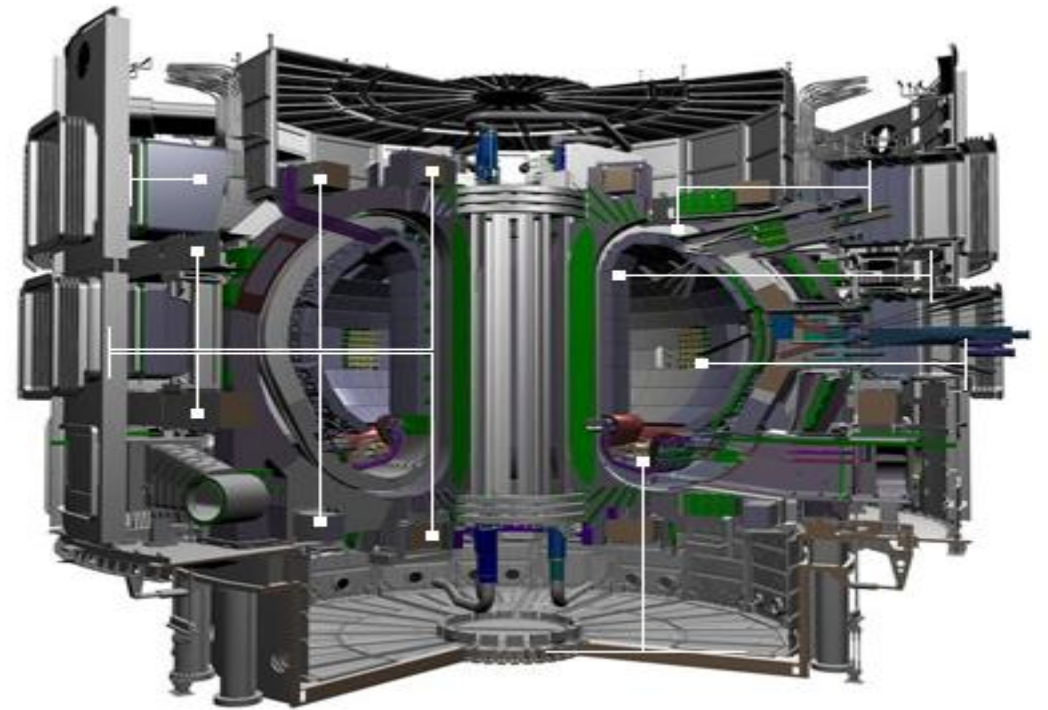
Where does the energy come from?

- Fusion Reaction

What Fusion can we do?

And would the atmosphere burn up?

No



HULK



HULK

'Lethal' dose of radiation, will lead to death.

Bruce Banner: 58kg

Hulk: ~550kg

Mass difference: 492kg, $E = mc^2$ gives an energy requirement of $4.428 \times 10^{19} \text{J}$

A kilo of flesh is equivalent to 7700 calories.

That's 3788400 calories, or ~ 2800 Big Mac Meals.

The Sandman

- Living Sand
- No biology
- Self Propelled
- Variable viscosity
- And just so broken...



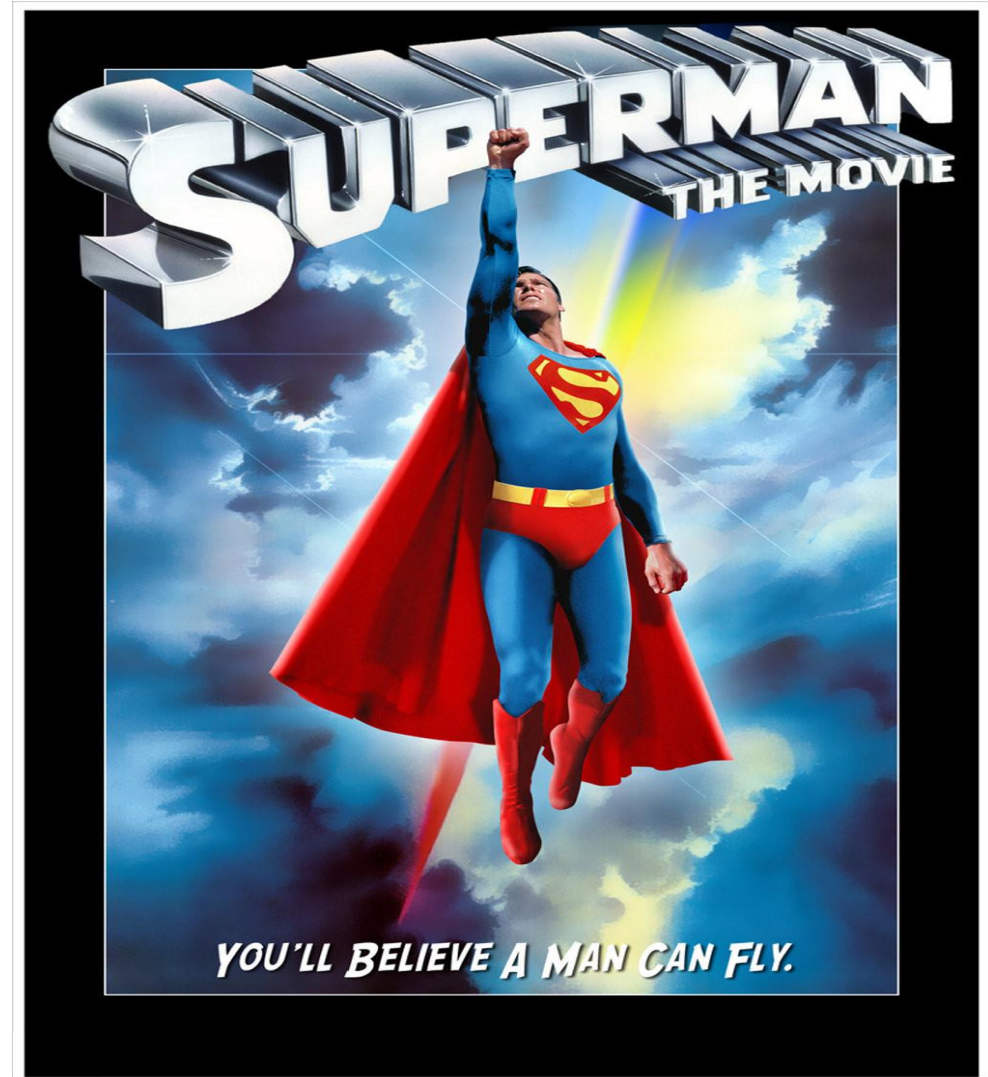
Relatively Terrible Physics

Superman (1978)

To save Lois Lane, he travels around the earth against its rotation at a speed faster than light, and goes back in time.

clip

<http://www.youtube.com/watch?v=TjgsnWtBQm0&feature=youtu.be&t=1m7s>



Why this does not work:

- First we assume:
 - Superman can fly at a speed faster than light
 - Doing so makes him go back in time
- These are terrible assumptions.
- Earth *should* gradually slow down as time dilation becomes noticeable
- In the scene, Earth does not slow down until maximum speed
- Earth remains stationary several seconds

The Black Hole (1979)

The protagonists' escape pod flies into a black hole.

They have psychedelic visions and come out of it alive.



Why this does not work:

- Gravity.
- Beyond Schwarzschild radius, escape speed is speed of light
- The pod would be torn into - not pieces - atoms.

Tachyons

- Hypothetical particle that moves faster than light
- Most physicists believe they cannot exist – inconsistency with known physics & no compelling evidence found
- Have been so widely used in sci-fi that it is more known as technobabble than a theoretical particle used by physicists

Tachyons

- *Land Of The Lost (2009)*
 - Will Ferrell invents a “**tachyon amplifier**” that can boost a strong signal of **tachyon energy** into a **time warp** that will lead to another universe



Tachyons

- *Prince Of Darkness* (1987)
 - Survivors of a possession in a church share a recurring dream which is actually a **tachyon transmission** sent from the future as a warning.



Tachyons

- *Fantastic Four (2007)*
 - Reed Richards uses a **tachyon pulse generator** with four amplifiers to disable the silver surfer and separate him from his board.



Broken Astronomy

Is there an asteroid “the size of Texas”?!

✓ The biggest asteroid in the solar system is 900 km across.

◆ Texas is 1,400 km across.

Asteroid; chance of getting smacked by a comet?

- The odds of a comet hitting an asteroid is very remote.
- One comet hitting two asteroids? Almost impossible.



Could a comet knock this particular asteroid out of its orbit?!

- Assuming an asteroid 500 km across made of iron as said in the movie would weigh around 5 million million million tons .

◆ Cant be even slightly moved with millions of comets.

Would this asteroid impact the surface of the planet with the force of 10,000 nuclear bombs?!

- Surprisingly this is a huge underestimate.
- Assuming that the asteroid is 10 km across moving with 11 km per second (minimum) the impact would release around 80,000,000 megatons of energy.
- Even if one assumes a 100 megaton bomb (rounded up) that's 800,000 nuclear bombs.

Would we not notice an asteroid well before it hits the Earth?

- ◆ Director of NASA: "We only have a million dollars to search the whole sky, and it's a big sky".
- An asteroid size of "Texas" or even the realistic size (900 km) would easily be visible 2 months earlier with naked eye.

Godzilla: Could it exist?



Basic Facts

Creature	Mass (kg)	Length/Height (m)
Human	80	1.8
African Saltwater Crocodile	2,000	4.5
African Bush Elephant	5,000	6
Blue Whale	190,000	25
Largest Sauropod	77,000	40
Godzilla	1.48×10^7	110

Square-Cube Law

- “When an object undergoes a proportional increase in size, its new surface area is proportional to the square of the multiplier and its new volume is proportional to the cube of the multiplier.”
- Explains why you can't simply scale up a creature to greater size e.g. King Kong.
- Problems also arise with Godzilla.

Metabolic rate and Kleiber's Law

- Describes Metabolic rate and energy consumption.

$$q_0 \propto M^{\frac{3}{4}}$$

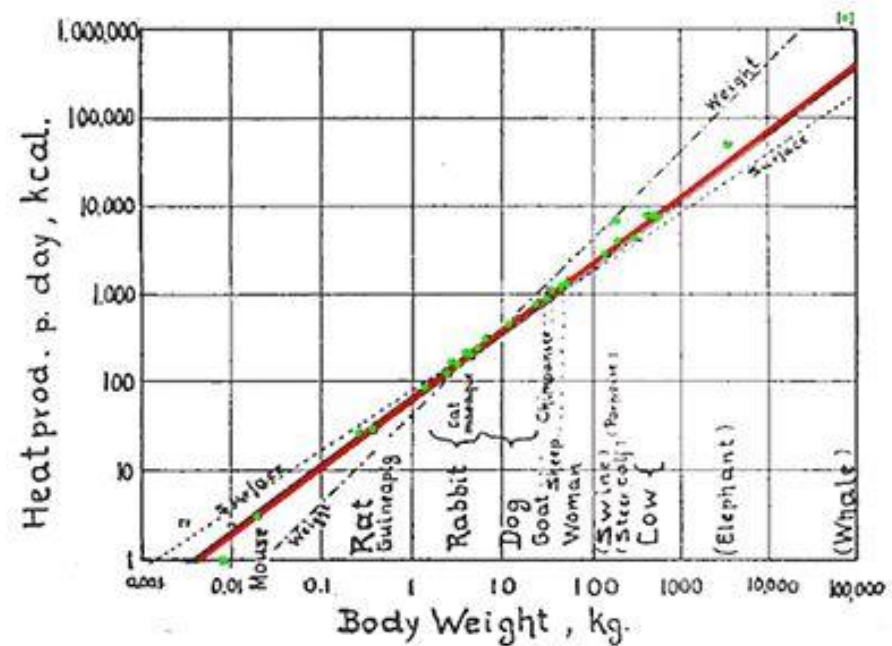


Fig. 1. Log. metabol. rate/log body weight

The Calorie problem

- After calculation, Godzilla requires approximately 215,000,000 calories to survive per day.
- It is unlikely it would be able to attain this kind of energy intake (ignoring eating radiation!)
- This number of calories also ties back to the Square-Cube law.

Radiation Breath

- Godzilla has the ability to expel dangerous radiation in beam as a form of weapon.
- This is very unlikely to be an effective and realistic idea for a number of reasons:
 - Formation of the Laser
 - Damage from the formation of the Laser